

## Open Centrifugal Refrigeration Machines

### A SAFETY GUIDE

Centrifugal liquid chillers are designed to provide safe and reliable service when operated within design specifications. When operating this equipment, use good judgment and safety precautions to avoid damage to equipment and property or injury to personnel.

Be sure you understand and follow the procedures and safety precautions contained in the machine instructions as well as those listed in this guide.

#### ⚠ DANGER

DO NOT USE OXYGEN to purge lines or to pressurize a machine for any purpose. Oxygen gas reacts violently with oil, grease and other common substances.

NEVER EXCEED specified test pressures. VERIFY the allowable test pressure by checking the instruction literature and the design pressures on the equipment nameplate.

DO NOT VALVE OFF any safety device.

BE SURE that all pressure relief devices are properly installed and functioning before operating any machine.

#### ⚠ WARNING

DO NOT USE eyebolts or eyebolt holes to rig machine sections or the entire assembly.

DO NOT work on high voltage equipment unless you are a qualified electrician.

DO NOT WORK ON electrical components, including control panels, switches, starters or oil heater until you are sure ALL POWER IS OFF and no residual voltage can leak from capacitors or solid-state components.

LOCK OPEN AND TAG electrical circuits during servicing. IF WORK IS INTERRUPTED, confirm that all circuits are de-energized before resuming work.

DO NOT syphon refrigerant by mouth.

AVOID SPILLING liquid refrigerant on skin or getting it into the eyes. USE SAFETY GOGGLES. Wash any spills from the skin with soap and water. If any enters the eyes, IMMEDIATELY FLUSH EYES with water and consult a physician.

NEVER APPLY an open flame or live steam to a refrigerant cylinder. Dangerous overpressure can result. When necessary to heat refrigerant, use only warm (110 F/43 C) water.

DO NOT REUSE disposable (nonreturnable) cylinders nor attempt to refill them. It is DANGEROUS AND ILLEGAL. When cylinder is emptied, bleed off remaining gas pressure, loosen the collar and unscrew and discard the valve stem. DO NOT INCINERATE.

CHECK THE REFRIGERANT TYPE before charging machine. High pressure refrigerant in a low pressure machine can cause vessels to rupture if the relief devices cannot handle the refrigerant volume.

DO NOT ATTEMPT TO REMOVE fittings, covers, etc.

while machine is under pressure or while machine is running. Be sure pressure is at zero psig before breaking any refrigerant connection.

CAREFULLY INSPECT all relief valves, rupture discs and other relief devices AT LEAST ONCE A YEAR. If machine operates in a corrosive atmosphere, inspect the devices at more frequent intervals.

DO NOT ATTEMPT TO REPAIR OR RECONDITION any relief valve when corrosion or build-up of foreign material (rust, dirt, scale, etc.) is found within the valve body or mechanism. Replace the valve.

DO NOT VENT refrigerant relief valves within a building; vent to outside. The accumulation of refrigerant in an enclosed space can displace oxygen and cause asphyxiation.

DO NOT install relief valves in series or backwards.

USE CARE when working near or in line with a compressed spring. Sudden release of the spring can cause it and objects in its path to act as projectiles.

#### ⚠ CAUTION

DO NOT STEP on refrigerant lines. Broken lines can whip about and cause personal injury.

DO NOT climb over a machine. Use platform, catwalk or staging. Follow safe practices when using ladders.

USE MECHANICAL EQUIPMENT (crane, hoist, etc.) to lift or move inspection covers or other heavy components. Even if components are light, use such equipment when there is a risk of slipping or losing your balance.

DO NOT WELD OR FLAME CUT any refrigerant line or vessel until all refrigerant has been removed from the vessel.

BE AWARE that certain automatic start arrangements CAN ENGAGE THE STARTER. Open the disconnect ahead of the starter in addition to shutting off the machine or pump.

USE only repair or replacement parts that meet the code requirements of the original equipment.

DO NOT VENT OR DRAIN water boxes containing industrial brines, liquid, gases or semisolids without permission of your Process Control Group.

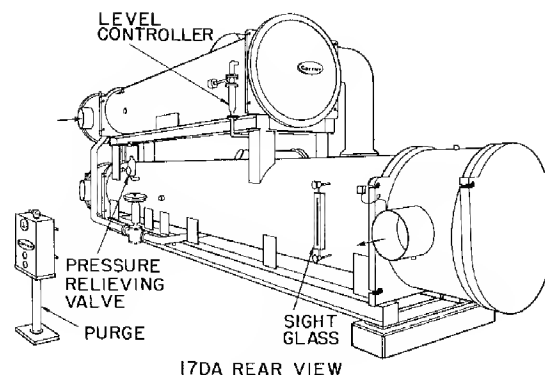
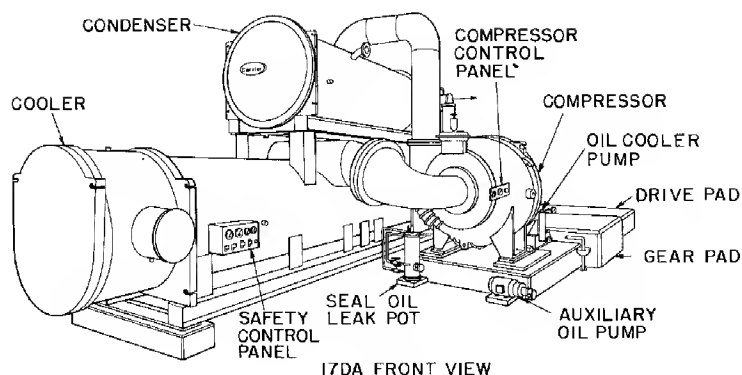
DO NOT LOOSEN water box cover bolts until the water box has been completely drained.

DOUBLE-CHECK that coupling nut wrenches, dial indicators or other items have been removed before rotating any shafts.

DO NOT LOOSEN a packing gland nut before checking that the nut has a positive thread engagement.

PERIODICALLY INSPECT all valves, fittings and piping for corrosion, rust, leaks or damage.

PROVIDE A DRAIN connection in the vent line near each pressure relief device to prevent a build-up of condensate or rain water.



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## INTRODUCTION

**General** — All persons concerned with the start-up and operation of the centrifugal refrigeration machine should be familiar with the equipment involved. This instruction book is intended to cover general rules for start-up procedures.

Because of machine variations it is not possible to prepare an instruction book covering all minor details. This instruction book will fulfill normal requirements. Additional information may be obtained by application to Carrier Machinery and Systems Division Service Supervisor in the nearest district office.

Special attention should be given to precautionary instructions emphasized in this book to avoid start-up difficulties. These precautions are, in general, applicable to all sizes of 17DA centrifugal refrigeration machines.

Instructions for the prime mover if not included with Carrier Air Conditioning instructions should be obtained from the manufacturer.

**Factory Test** — Prior to shipment, the compressor is completely assembled and tested. Performance as to lubrication, speed balance and general mechanical operation has been determined to be satisfactory.

**Job Data** — consists of:

1. 17DA Start-Up Instructions
2. Blueprints showing:
  - a. Machine assembly
  - b. Machine wiring
  - c. Machine piping
  - d. Special controls, if any, and related wiring
3. 17DA Installation Instructions
4. 17DA Operation and Maintenance Instructions
5. Manufacturer's Installation and Start-Up Instructions for:
  - a. Drive
  - b. Gear (if applicable)

**Table 1 – Essential Tools**

ITEM	USE
1. Mechanic's tools	1. Machine piping connections, control calibration
2. Dial indicators	2. Check alignment
3. Volt-ohmmeter	3. Calibrate controls
4. Drum charging valve	4. Refrigerant charging connection
5. 5/8-inch SAE x 3/4-inch MPT adapter	5. Cooler charging valve
6. 5 to 10 ft length of 5/8-inch soft copper tubing with 5/8-inch flare nut on each end	6. Charging line
7. Halide leak detector or electronic leak detector	7. Leak testing machine
8. Low-pressure indicator such as: a. Absolute pressure manometer or b. Vacuum indicator	8. Check machine dehydration
9. Portable dehydration vacuum pump – 5 or 7.5 cfm capacity	9. Dehydrating machine
10. 1/2-inch flare plug	10. Block purge suction line during leak testing

**Essential Tools** – See Table 1 for tools and materials required to perform initial start-up.

### INSPECT AND ADJUST

**Machine Room** – All installation work as outlined in 17DA Installation Instructions book should be completed, and all construction debris must be removed from the immediate area of the machinery prior to initial start-up of the machine.

**Drive Arrangement** – Inspect drive mounting, location, coupling, speed rating, etc., for agreement with job blueprints and specifications. Gear assembly (if used) must agree with installation recommendations outlined in gear manufacturer's instructions.

**Piping** – Check the following installations:

1. Refrigerant pumpout system
2. External or auxiliary oil system
3. All bypass lines and valves
4. Turbine drive piping, i.e.
  - a. Blowdown valves for each turbine stage installed per manufacturer's instructions.
  - b. Oil lubrication piping for speed control installed in agreement with blueprints.
  - c. Steam supply line condensate traps properly installed to keep condensate out of turbine.
  - d. Proper supports on steam supply and exhaust line to prevent stress or strain on the turbine at operating temperatures.
5. Gas engine drive piping – Check the following piping for agreement with job blueprints:
  - a. Gas pressure reducing valves with shutoff valves.
  - b. Engine coolant piping with coolant thermostatic valve installed so that water flows in direction marked on valve.
  - c. Oil cooler package piping
  - d. Exhaust piping

**WARNING:** Exhaust piping is critical. Refer to drive manufacturer's recommendations for installation of exhaust piping.

**Wiring** – Refer to job wiring blueprints. All wiring must agree with these prints.

**AUXILIARY EQUIPMENT WIRING** – Check the following:

1. Brine pump
2. Condenser water pump
3. Cooling tower fan motor
4. Auxiliary oil pump
5. Oil heater
6. Overload selections in all motor starters. Overload values must agree with motor nameplate data.

**TURBINE DRIVE WIRING** – Check the following:

1. Turbine solenoid trip mechanism.
2. Auxiliary oil pump if used. Check pump starter for proper voltage, amperage, and overload setting. Operate pump to determine direction of rotation. Do not operate dry of oil.
3. Check job drawings for other electrical devices used with the turbine. Ensure that their wiring agrees with the job wiring blueprints.

**GAS ENGINE DRIVE WIRING** – All wiring must agree with job wiring blueprints. Refer to engine manufacturer's instructions for starting techniques.

**Safety Controls** – It is good machinery practice to preset safety controls using standard temperature sources; i.e., ice baths, warm circulating oil baths with standard calibrated thermometers. All controls must be rechecked during machine operation and given final calibration as required. See Table 2 Control Settings and Fig. 1 17DA Safety Instrument Panel.

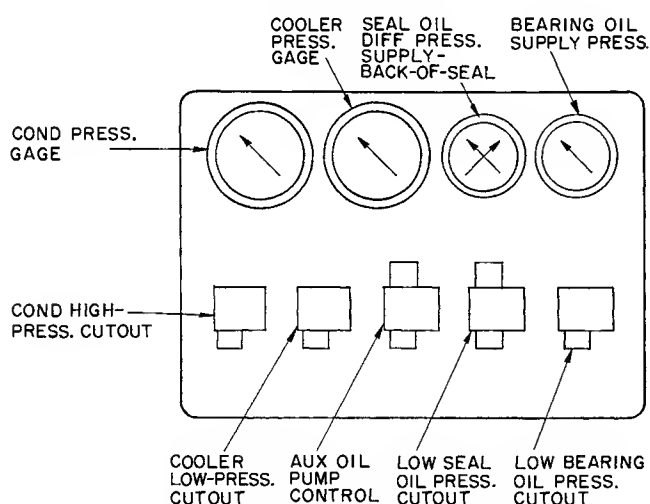
Check the following safety controls as shown on job blueprints:

1. Main drive de-energizing devices, i.e.
  - a. Starter holding coil
  - b. Turbine solenoid trip, etc.
2. Brine low-temperature cutout
3. Refrigerant low-pressure cutout

**Table 2 – Control Settings**

CONTROL	LOCATION	SETTING	
		British Values	Metric Values
Low Chilled Water Temperature Cutout	Cooler Water Box	38 F or 5 F lower than brine temperature	1.7 C
High Discharge Gas Temperature Cutout	Compressor End Wall	240 F	115 C
High Thrust Bearing Temperature	Compressor Bearing Chamber	180 F	82.5 C
High Condenser Pressure Cutout	Control Panel	165 psig	11.6 kg/sq cm
Low Cooler Pressure Cutout	Control Panel	Vendor set at 35 psig. Reset 2 psi below normal suction pressure.	2.45 kg/sq cm .14 kg/sq cm
Low Seal Oil Pressure Cutout	Control Panel	Open 11 psid Close 16 psid	.76 kg/sq cm 1.16 kg/sq cm
Low Bearing Oil Pressure Cutout	Control Panel	Open 8 psig Close 13 psig	.56 kg/sq cm .90 kg/sq cm
Auxiliary Oil Pump Differential Pressure Control Switch	Control Panel	Open 27 psid Close 23 psid	1.90 kg/sq cm 1.60 kg/sq cm

4. Oil low-pressure switches
5. Condenser high-pressure cutout
6. Check the following optional safety devices:
  - a. Brine flow switch
  - b. Condenser water flow switch
  - c. Condenser refrigerant level switch
  - d. Drive protection devices
  - e. Pump interlocks
  - f. Special interlocks, timers, etc.



**Fig. 1 – 17DA Safety Instrument Panel**

**MOTOR DRIVE** – Disconnect the main motor leads at the starter to check out the safety controls without operating the motor. Disconnecting the leads to the starter holding coil will accomplish the same purpose. Place a volt-ohmmeter across the open leads. The volt-ohmmeter will indicate when the safety control circuit is de-energized as each safety control is tripped.

**TURBINE OR GAS ENGINE DRIVE** – These drives are shut down by interruption of power to their respective control valves or other devices. Apply a volt-ohmmeter across these open leads and check out all safety controls as just described.

**PUMPOUT SYSTEM** – The low-pressure cutout should be set at the saturated pressure of Refrigerant-12 at 34 F. A manual bypass switch is required to allow complete evacuation of the cooler. See Table 3.

**Table 3 – Pumpout System Settings**

PUMPOUT SYSTEM SETTING	SATURATED CONDITIONS REFRIGERANT 12	
	Pressure (psig)	Maximum Temperature (F)
Normal Condensing Pressure	136.4	110
Low-Pressure Cutout	31.5	34
High-Pressure Cutout	157.7	120
Relief Valve	181.0	130

## LEAK TEST AND DEHYDRATION

Check the absolute pressure on the refrigerant side of the machine. The final operation of the 17DA Installation Instruction is to leak test the machine and dehydrate it to the point where it maintains a pressure of 0.21 psia (equivalent to 29.48 in. mercury vacuum referenced to a 30 in. barometer). Refer to Carrier Standard Service Techniques, Form SM-1.

If the machine absolute pressure is higher than the above values, repeat the Evacuation and Dehydration pumpdown operations until the machine proves to have a leak rate or vacuum loss at a rate less than 0.1 in. mercury column in 24 hr.

## CHARGE MACHINE WITH WATER

When the machine has been proved leak tight and dry, it may be filled with water, brine or other process fluid as the case may be. Vent all lines and check for leaks.

It is advisable to install indicators on the coupling halves between the compressor and drive

or gear to check for alignment drift while charging with water and refrigerant. The weight of these materials will always cause a shift in the position of the machine components. Before and after indicator readings will give a good clue to the direction final alignment should take.

### CHARGE MACHINE WITH OIL

The 17DA machine has an integral lubrication system mounted on the common base with the compressor. A parallel auxiliary oil pump system may also be furnished. Charge the oil system with 35 gal. of oil per Carrier Specification PP16-0 (Table 4). If oil other than this is used, the replacement oil must be nearly equivalent.

Ensure that there is adequate lubrication prior to the operation of all equipment. Check the gear and drive manufacturer's instructions for proper initial lubrication procedure. If the drive machinery is to be operated before operating the compressor, disconnect the shaft coupling and secure the shroud to prevent damage to the drive shaft or the coupling.

Oil pressure from the main oil pump is set at a pressure 35 psi greater than the back-of-seal oil pressure. If, for any reason, the oil pressure falls to 23 psi above the back-of-seal oil pressure, the auxiliary oil pump starts and maintains oil pressure at a safe level.

**Table 4 — Oil Specification (Carrier PP16-0)**

CHARACTERISTIC	VALUE
Viscosity at 100 F	150 – 160 SSU
Viscosity at 210 F	40 – 45 SSU
Viscosity Index, minimum	90
Pour Point, maximum	0 F
Flash Point, minimum	400 F
Neut. No., maximum	.1 mg. KOH/gm.
Rust Inhibiting Characteristics	The material shall pass the ASTM Rust Test D665-54. Procedure A will be used with a test period of 24 hr.
Oxidation Resistance	The material shall pass the ASTM Oxidation Test D943-54 for a minimum of 1500 hr. The acid number at the end of the test period shall not exceed 2.0 mg. of KOH per gram of oil.

SSU — Saybolt Seconds Universal

### FINAL PREOPERATION ALIGNMENT CHECK

Prior to operating the compressor and speed increasing gear (if used), coupling alignment and separation must be checked.

1. Ensure that coupling alignment is within coupling manufacturer's specified tolerances.
2. The hub separation tolerances are normally stamped on coupling and vary depending on coupling size.

3. When checking hub separation, electric motor shaft must be in center position of shaft float.

If realignment is required, follow instructions supplied by coupling manufacturer. Carrier Standard Service Techniques, Form SM-15, Rev A, also details realignment techniques.

### OPERATE DRIVE

It is good practice to operate the drive separately before operating compressor. Refer to drive manufacturer's instructions for drive protection devices and settings. Check turbine overspeed at this time. Reassemble couplings after operating drive separately.

### SET PURGE VALVES AND SWITCHES

Open all the purge service valves behind purge console. Place purge operating valves in NORMAL-AUTOMATIC position (shown on chart inside console door). Place purge switch in AUTO position.

### CHECK WATER SUPPLY

Be certain that chilled water, condensing water and oil cooler water supplies are available and that pumps will run before operating compressor.

### CHECK AIR SUPPLY, PNEUMATIC MACHINES

Make sure that control air is 35 psig.

### START-UP

**Preoperation Settings** — Complete these settings before starting compressor for first time.

**Drive Operation** — Refer to drive manufacturer's start-up instructions. Complete drive starting requirements before operating compressor.

If drive is wired for automatic starting, it will start when compressor START button is pushed. Starting procedure of manually started drives may be initiated after START button is pushed.

### Compressor Operation

1. Place control switch in ON position. Condenser pressure, bearing temperature and refrigerant temperature indicating lights on control console should come on.
2. Place capacity control switch in MANUAL position.
3. Open oil cooler water plug cock. Check for water flow at open sight drain.
4. Open bleed valve on inboard side of the compressor.
5. Open all valves and energize heater on seal oil drain pot.
6. Open all valves in chilled water and condenser water circuits.

**WARNING:** No brine over 100 F must be allowed to flow thru the cooler.

7. Ensure that there is water in the cooling tower.
8. If the auxiliary equipment such as chilled water pump, condenser water pump, and cooling tower fan are not wired into control console circuit, start these items manually before starting the compressor.
9. Start oil pump.
10. Close bleed valve on inboard side of the compressor.
11. 17DA compressors are equipped with an AUTO-MANUAL control station. The initial start should be on manual control from this station.
12. Start compressor.
  - a. Bump electric motors by pushing the START and STOP buttons in quick succession. Compressor rotation must be counterclockwise when viewed from drive end.
  - b. Run turbine or engine drives at slow speed.
13. Listen carefully for unusual mechanical noise while coasting down.
14. Shut down.

#### Charge Refrigerant

**WARNING:** When liquid Refrigerant-12 is injected into a low vacuum of 29.48 in. mercury it will immediately flash to a gas at a temperature lower than minus 100 F. It is for this reason that water must be circulating before charging liquid refrigerant. Noncirculating water would quickly freeze and damage the machine. If an auxiliary refrigerant storage tank (receiver) is furnished, liquid refrigerant may be charged directly into this evacuated receiver without danger.

Large machines run with liquid refrigerant in the cooler so refrigerant is charged into the cooler or low-pressure side of the machine. For general instructions on how to handle refrigerant refer to Carrier Standard Service Techniques, Form SM-1. Use the Charging by Weight method, cross checking with the machine's refrigerant sight glass provided on the back of the cooler shell, and the suction pressure gage.

Charge refrigerant as follows:

1. Start Cooler and Condenser water circulating pumps.
2. Charge the first refrigerant in the vapor state, continuing until the machine pressure exceeds 35 psig. The refrigerant temperature corresponding to this pressure is high enough to

prevent water freezing damage and will also satisfy the refrigerant low-pressure cutout safety switch setting (31.5 psig). Now turn the refrigerant bottles or drums over and begin charging the refrigerant in the liquid phase. Continue charging liquid refrigerant until about 2/3 of the estimated full load charge is in the machine.

3. Adjust control station to operate at MANUAL. Ensure that the guide vanes are closed as indicated on the main guide vane indicator.
4. Set Subcooler Level Controller as follows:
  - a. Set Proportional Band at 35%.
  - b. Set Level-Set adjustment at 50%.

When stable operation is achieved, readjust Level-Set to maintain the liquid level at the midpoint of the sight glass on the Level Controller. Recheck this level when full load is reached and reset if necessary.

5. Start the compressor. Observe the machine's operation for 15 - 20 min before increasing the load. During this period, make the following checks and adjustments:
  - a. Check oil pressure.
  - b. Adjust water flow thru oil cooler so that bearing temperatures stay between 150 F and 170 F approximately.
  - c. Watch bearing temperatures carefully. This is the first time that the machine has been run under refrigeration load. Bearing temperatures may level off at some temperature slightly higher than 170 F listed above. This may be the normal stable condition for this bearing. High thrust bearing temperature will shut the machine down at 180 F.
6. Slowly open the guide vanes, by manual control, thus increasing the load. Do not exceed the current rating of the electric motor. Watch for other signs of overloading a turbine or engine drive.
7. Add liquid refrigerant, trimming the charge off at the point where the machine reaches design operating temperature and pressure conditions.

**WARNING:** Excessive overcharge may cause liquid refrigerant carry-over into the compressor, causing severe overload and possible compressor damage.

8. Shut the machine off. When the refrigerant level settles down, mark this optimum level on the sight glass. Maintain this shutdown level. To determine the approximate refrigerant charge for your machine, add the cooler charge to the applicable condenser charge as listed in Table 5.

**Table 5 — Typical 17DA Cooler and Condenser Refrigerant Charges (lb)**

COOLER SIZE	15-FT TUBES	18-FT TUBES	22-FT TUBES	COND SIZE	REFRIG WT
61	3,300	3,900	4,800	61	2200
63	4,000	4,700	5,800	63	2200
65	4,000	4,700	5,800	65	2700
67	4,600	5,600	6,800	67	2700
651*	3,500	4,200	5,100	651*	2500
671*	4,200	5,000	6,100	671*	2500
71	5,100	6,100	7,500	71	2900
73	5,500	6,500	8,000	73	2900
75	6,100	7,300	8,900	75	3400
81	7,100	8,500	10,400	81	3900
83	7,600	9,200	11,200	83	4400
85	8,500	10,100	12,400	85	5100
87	9,500	11,400	13,900	87	4900

\*Refrigerant 500

### HOT ALIGNMENT CHECK AND DOWELING

After the machine has been running at about full load for four hours, its components will have come up to steady state operating temperature conditions and the final hot alignment check may be made.

Realign component locations until angular and parallel alignments are within coupling manufacturer's specified tolerances.

Dowel all equipment into place as soon as the hot alignment check proves that the machine is within these running tolerances.

See Carrier Standard Service Techniques, Form SM-15, Rev A, for these operations.

### INSTRUCT CUSTOMER OPERATOR

The following is an outline guide for giving operating instructions to the customer's operator.

1. Present operator with copy of Operating and Maintenance Instructions.
2. Point out machine components and explain function and settings for each.
  - a. Controls
    - (1) Safety panel, gages and safety switches
    - (2) Control station, manual-automatic modes
  - b. Compressor
    - (1) Oil reservoir
    - (2) Seal
    - (3) Guide Vanes
    - (4) Auxiliary oil pump, filter and cooler
    - (5) Bleed valve
  - c. Cooler
    - (1) Refrigerant level sight glass
    - (2) Pressure relieving valve
  - d. Condenser
    - (1) Sub-cooler
    - (2) Leveltrol

- e. Purge
  - (1) Operation
  - (2) Maintenance
- f. Drive and gear
- g. Pumpout system (if supplied)
- h. Auxiliary gages and thermometers
3. Refrigerant cycle
  - a. Explain system
  - b. Importance of log sheets
4. Describe compressor lubricating oil system.
  - a. Oil heater
  - b. Oil cooler
  - c. Pressure regulating valve, back pressure valves, etc.
  - d. Auxiliary oil system (if supplied)
5. Point out safety and operating controls and explain function of each.
  - a. Standard controls
  - b. Special controls
6. Instruct proper operating procedure.
  - a. Preparation for start-up (valves, electrical, etc.)
  - b. Starting methods
  - c. Running measurements and maintenance of log
  - d. Shutdown
  - e. Extended shutdown
7. Review maintenance items.
  - a. Daily
  - b. Items to watch
  - c. Extended shutdown
  - d. Water treatment and strainer cleaning
8. Review spare parts lists.
9. Advise regarding Carrier Planned Service.
  - a. Maintenance contracts
  - b. Inspection Contracts
  - c. Carrier Regional Service Schools
10. Review special features of machine.
  - a. Operation of pumpout system and valve settings
  - b. Drive maintenance and operating precautions
  - c. Starter settings and location
11. Leave phone number of Machinery and Systems Division, Carrier Corp. for quick reference.
12. Review questions and answers on Operation and Maintenance Instructions.
13. Advise on start of Warranty Period.

For replacement items use Carrier Specified Parts.

Manufacturer reserves the right to discontinue, or change at any time, specifications or designs without notice and without incurring obligations.

Book	2
Tab	5d

Form 17DA-2SS Supersedes 17DA-1SS

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